

### **REMARKS**

Claims 1, 5, 7, 10, 13-14, and 16 are now pending in the application. Applicant amends claims 1, 5 and 7, cancels claim 4, and adds new claim 16. Support for the amendments and new claims can be found throughout the specification, claims and drawings as originally filed. Accordingly, no new matter is added. Applicant respectfully requests reconsideration and withdrawal of the rejections in view of the amendments and remarks contained herein.

### **REJECTION UNDER 35 U.S.C. § 112**

Claims 1, 4-5, 7, 10 and 13-14 stand rejected under 35 U.S.C. § 112, first paragraph, as failing to comply with the written description requirement. This rejection is respectfully traversed.

Claim 1 is amended to delete the feature of "the gate insulating material having a first region where B/A is 10 or less." Further, claim 1 is amended to recite that the "gate insulating film [has] a region where B/A is in a range of 1.6 to 10." By these amendments, Applicant respectfully submits that the claims comply with 35 U.S.C. § 112, first paragraph. Reconsideration and withdrawal of this rejection, therefore, are respectfully requested.

### **REJECTION UNDER 35 U.S.C. § 103**

Claims 1, 4, 7, 10 and 13-14 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Kusunoki et al. (U.S. Pat. Pub. No. 2002/0066934); and Claim 5 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over Kusunoki et al.



(U.S. Pat. Pub. No. 2002/0066934) in view of Hori et al. (U.S. Pat. No. 6,215,163).

These rejections are respectfully traversed.

It is a longstanding rule that to establish a prima facie case of obviousness of a claimed invention, all of the claim limitations must be taught or suggested by the prior art. *In re Royka*, 180 USPQ 143 (CCPA 1974), see MPEP §2143.03. Here, Applicant notes that claim 1 is amended to recite:

1. A semiconductor device comprising:
  - a base including a semiconductor material, the base having a source region, a drain region, and a channel region disposed between the source region and the drain region;
  - a gate insulating film disposed in contact with the channel region of the base; and
  - a gate electrode disposed on the gate insulating film;
- the gate insulating film being composed of silicon oxide including either hydrogen or deuterium, and nitrogen,
- the nitrogen being diffused to the gate insulating film so as to reduce the hydrogen or the deuterium residing in the vicinity of an interface between the gate insulating film and the channel region of the base,
- the gate insulating film having a region where B/A is in a range of 1.6 to 10, a concentration of the nitrogen in the region being defined as A, a concentration of the hydrogen or the deuterium in the region being defined as B, and
- the region being located at a portion of the gate insulating film at a distance toward a thickness direction of Y/10 of the gate insulating film from the interface, Y being an average thickness of the gate insulating film.

As recited by claim 1, the claimed invention includes the feature a gate insulating film that is composed of silicon oxide including either hydrogen or deuterium, and nitrogen. The nitrogen is diffused to the gate insulating film so as to reduce the hydrogen or the deuterium residing in the vicinity of an interface between the gate insulating film and the channel region of the base. Please see lines 7-14 of page 28 of the present application. By diffusing the nitrogen to the gate insulating film composed of



silicon oxide ( $\text{SiO}_2$ ) including either hydrogen or deuterium, and nitrogen, the hydrogen or the deuterium residing in the vicinity of an interface between the gate insulating film and the channel region of the base is reduced so that the gate insulating film has the region satisfying the above condition. This results in the gate insulating film having high resistance to dielectric breakdown (such as SILC, SBD) while maintaining, for example, the stable insulating properties of  $\text{SiO}_2$ . Kusunoki fails to teach or suggest these features and, therefore, all of the claim limitations are neither taught nor suggested by the prior art. *Id.*

In contrast to the features of claim 1, Kusunoki discloses a semiconductor device having a gate insulating film comprising RNO films (12) and a NO film (22). Please see Fig. 1 of Kusunoki. The RNO films (12) are silicon nitride oxide films, which contain silicon, oxygen, nitrogen at a content of  $2.5 \times 10^{20} / \text{cm}^3$  or more and hydrogen at a content less than  $3 \times 10^{20} / \text{cm}^3$ . The NO film (22) is a silicon nitride oxide film which contains silicon, oxygen, nitrogen at a content of  $2.5 \times 10^{20} / \text{cm}^3$  or more and hydrogen at a content of  $3 \times 10^{20} / \text{cm}^3$  or more. Accordingly, the gate insulating film of Kusunoki comprises RNO films (12) and a NO film (22) that are composed of silicon nitride oxide (SiNO), while the gate insulating film of the claimed invention is composed of silicon oxide ( $\text{SiO}_2$ ). The gate insulating film of Kusunoki, therefore, is completely different from the gate insulating film of the claimed invention due to the presence of nitride.

Further, the gate insulating film of Kusunoki is formed by nitriding a silicon oxide film to form a silicon nitride oxide film (that is, the NO film (22)), and annealing or oxidizing a portion of the silicon nitride oxide film at a temperature of  $800^\circ\text{C}$  to  $1000^\circ\text{C}$  to form the RNO films (12). In contrast to such a method, the gate insulating film of the



claimed invention is formed by only diffusing the nitrogen to a silicon oxide film. Therefore, the gate insulating film of Kusunoki requires more complicated step than that of the gate insulating film of the claimed invention to obtain the gate insulating film having high resistance to dielectric breakdown.

For the above reasons, Applicant respectfully submits that Kusunoki does not disclose the features of the claimed invention. Accordingly, the claimed invention would not have been obvious in view of Kusunoki.

#### **NEW CLAIMS**

New claim 16 is added. Support for this new claim can be found throughout the specification, claims and drawings as originally filed. Accordingly, no new matter is added.

New claim 16 recites that the gate insulating film is composed of silicon oxide including either hydrogen or deuterium, and at least one other element selected from a group comprising carbon, aluminum, hafnium, zirconium and germanium. Kusunoki does not disclose or suggest that the gate insulating film contains at least one other element selected from a group comprising carbon, aluminum, hafnium, zirconium and germanium. Inasmuch as the prior art fails to teach or suggest all of the claim limitations, the prior art cannot render claim 16 unpatentable. Therefore, Applicant respectfully requests favorable consideration of this new claim.



## CONCLUSION

It is believed that all of the stated grounds of rejection have been properly traversed, accommodated, or rendered moot. Applicant therefore respectfully requests that the Examiner reconsider and withdraw all presently outstanding rejections. It is believed that a full and complete response has been made to the outstanding Office Action and the present application is in condition for allowance. Thus, prompt and favorable consideration of this amendment is respectfully requested. If the Examiner believes that personal communication will expedite prosecution of this application, the Examiner is invited to telephone the undersigned at (248) 641-1600.

Respectfully submitted,

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